TM 11-5102

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DECADE RESISTORS
ZM-16/U AND
ZM-16A/U

UNITED STATES OF AMERICA
WAR OFFICE
MDCCLXXVIII

DEPARTMENT OF THE ARMY • DECEMBER 1955

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DEPARTMENT OF THE ARMY TECHNICAL MANUAL
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TECHNICAL MANUAL

RESISTORS, DECADE ZM-16/U AND ZM-16A/U

TM 11-5102
CHANGES No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *18 February 1960*

TM 11-5102, 20 December 1955, is changed as indicated so that the manual also applies to the following equipment:

Nomenclature	*Order No.*	*Serial No.*
Resistor, Decade ZM-16A/U---------	3483-PP-59-A3-A3	1 through 199

Change the title of the manual to: **RESISTORS, DECADE** ZM-16/U and ZM-16A/U.

Page 3, chapter 1. Add the following "Note" below the title of chapter 1.

Note. Resistor, Decade ZM-16A/U procured on Order No. 3483-PP-59-A3-A3 is similar to previous procurements of Resistor, Decade ZM-16A/U. Information in this manual applies to both decades unless otherwise specified.

1. Scope.

(Superseded)

a. General. This manual contains information on the operation, maintenance, repair, and theory of operation of Resistors, Decade ZM-16/U and ZM-16A/U (figs. 1 and 2). Throughout this manual, the word decade refers to either Resistor, Decade ZM-16/U or ZM-16A/U or both.

b. Comments on Manual. Forward comments on this manual directly to the Commanding Officer, U.S. Army Signal Publications Agency, Fort Monmouth, N.J.

2. Forms and Records.

(Superseded)

a. Unsatisfactory Equipment Reports.

(1) Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to the Commanding Officer, U.S. Army Signal Equipment Support Agency, Fort Monmouth, N.J., as prescribed in AR 700-38.

(2) Fill out and forward AF TO Form 29 (Unsatisfactory Report) to the Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00-35D-54.

TAGO 4231B—Feb. 520484°—60

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army), Navy Shipping Guide, Article 1850–4 (Navy), and AFR 71–4 (Air Force).

Page 4, figure 2. Add the following note to figure 2:

NOTE:

ON THE ZM–16A/U (ORDER NO. 3483–PP–59–A3–A3), SWITCH MARKINGS FOR THE UPPER RIGHT, CENTER, AND LOWER LEFT SWITCHES ARE AS FOLLOWS:

LOCATION	MARKING
UPPER RIGHT	X100000 2.0 MA MAX
CENTER	X1000 20 MA MAX
LOWER LEFT	X10 200 MA MAX

Page 10, paragraph 10*a*, chart, column 2, "ZM–16A/U (fig. 2)". Make the following changes:

Line 3. After "220 MA MAX" add: (200 MA MAX on ZM–16A/U (Order No. 3483–PP–59–A3–A3)).

Line 5. After "22 MA MAX" add: (20 MA MAX on ZM–16A/U (Order No. 3483–PP–59–A3–A3)).

Line 7. After "2.2 MA MAX" add: (2.0 MA MAX on ZM–16A/U (Order No. 3483–PP–59–A3–A3)).

Page 26, figure 8. Add the following to the notes:

4. ON THE ZM–16A/U (ORDER NO. 3483–PP–59–A3–A3), SWITCH MARKINGS FOR THE UPPER LEFT, CENTER, AND LOWER RIGHT SWITCHES ARE AS FOLLOWS:

LOCATION	MARKING
UPPER LEFT	X100000 2.0 MA MAX
CENTER	X1000 20 MA MAX
LOWER RIGHT	X10 200 MA MAX

[AG 412.42 (25 Jan 60)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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JBUSMC (2)
USA Sig Pubs Agcy (8)
Army Pictorial Cen (2)
USA Ord Msl Comd (3)
Units organized under following TOE's:
5–278 (2)
11–7 (2)
11–16 (2)
11–57 (2)
11–97 (2)
11–117 (2)
11–155 (2)
11–158 (2)
11–500 AA–AE (2)
11–557 (2)
11–587 (2)
11–592 (2)
11–597 (2)

NG: None.
USAR: None.
For explanation of abbreviations used, see AR 320–50.

U.S. GOVERNMENT PRINTING OFFICE: 1960

TECHNICAL MANUAL
No. 11-5102

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *20 December 1955*

DECADE RESISTORS ZM-16/U AND ZM-16A/U

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information on the operation, maintenance, repair, and theory of operation of Decade Resistors ZM–16/U and ZM–16A/U (figs. 1 and 2). Throughout this manual, the word decade refers to either Decade Resistor ZM–16/U or ZM–16A/U or both.

b. Forward comments on this manual directly to the Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of army equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in AR 700–38.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Purpose. The decade is a single portable unit that provides fixed, accurate, conveniently selectable resistance values.

b. Use. The decade is used as a substitute for original meter multiplier or shunt resistors. The decade is used as follows: as a resistance standard in the calibration of ohmmeters; in direct current (dc) circuits, or alternating current (ac) circuits up to approximately 60 cycles per second (cps) requiring a wide range of fixed resistance values; where load resistances are required; as ratio arms for dc or low frequency (60 cps) bridges; and whenever test or repair work requires a precision resistor. The decade is not suitable for applications above 60 cps.

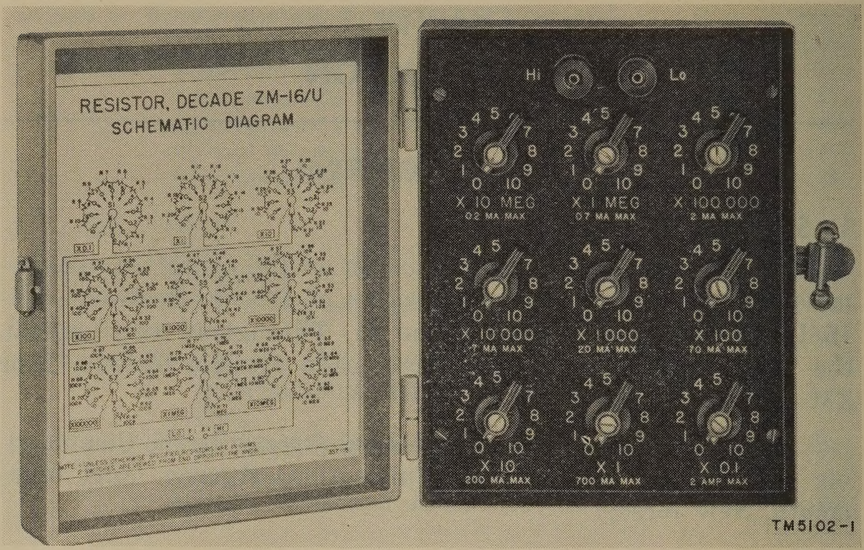


Figure 1. Decade Resistor ZM–16/U.

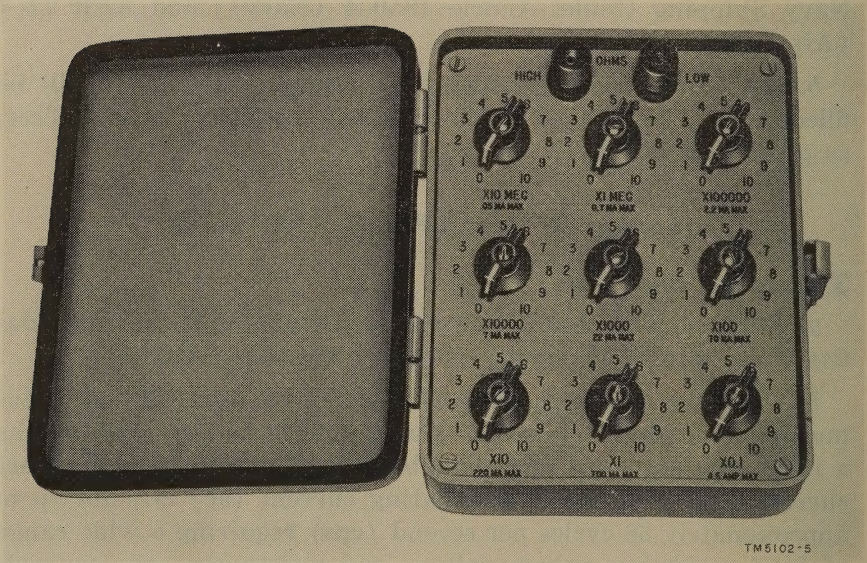


Figure 2. Decade Resistor ZM–16A/U.

4. Technical Characteristics

Resistance range	.1 ohm through 111,111,111 ohms ±1 percent (except for the X 0.1 decade switch, which is ±2 percent).
Number of decade switches	9.
Contacts per decade switch	11.
Resistors per decade switch	10.
Dc resistance of decade (with all decade switch controls at 0).	Between .045 and .05 ohm.
Resistor composition as follows:	
X 0.1 decade switch	Manganin wire with a temperature coefficient of ±.002 percent per degree between 20° and 82° C. (68° and 148° F.).
All other decade switches	Metallic film with a temperature coefficient of .04 to .02 percent per degree between 20° and 82° C. (68° and 148° F.).
Decade switches	Rotary; 13 silver-plated, phosphor-bronze contacts. Contact resistance per decade switch is less than .005 ohm.

5. Packaging Data
(fig. 3)

a. Domestic Shipment. Each decade, cushioned by corrugated fillers, is placed in a close-fitting, inner corrugated carton 3¾ inches high by 7⅜ inches wide by 8¼ inches deep. Eight of these inner corrugated cartons are packed in an outer corrugated carton for shipment. The dimensions of each outer corrugated carton (containing eight individually packaged decades) are 18½ inches high by 9½ inches deep by 17 inches wide. The carton weighs 30 pounds and has a volume of 1.68 cubic feet.

b. Oversea Shipment. The oversea inner corrugated carton for a single decade contains desiccant and is identical with that used for domestic shipment (*a* above). Eight individually packaged decades are contained in an outer corrugated carton which is packed in a wooden packing case lined with a moisture-vaporproof barrier. The dimensions of each wooden packing case are 22½ inches high by 11½ inches deep by 19 inches wide. The packaged wooden packing case weighs 55 pounds and has a volume of 2.77 cubic feet.

6. Description of Decade

a. Panel and Case. The ZM–16/U (fig. 1) is housed in an aluminum, waterproof case with a removable cover. The ZM–16A/U (fig. 2) has a plastic case. Nine decade switches and two binding posts are mounted on the front panel. A snap lock hasp secures the closed cover.

b. Decade Switch Controls. Nine decade switch controls are mounted on the front panel. The maximum current and the resistance multiplier range are marked on the panel at the bottom of each decade switch control.

c. Dimensions and Weight. The ZM–16/U is 3 inches high by 7 inches wide by 7⅝ inches deep. The ZM–16A/U is 3⅛ inches high by 5¾ inches wide by 7¼ inches deep. Each model weighs 2½ pounds.

CHAPTER 2

OPERATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

7. Uncrating, Unpacking, and Checking New Equipment

a. General. Be very careful when unpacking or handling the equipment. It is a precision instrument and mishandling may cause damage.

b. Uncrating and Unpacking Oversea Packages (fig. 3).

(1) Place the wooden packing case in a convenient location.

(2) Cut and fold back the metal straps.

(3) Remove the nails with a nail puller. Remove the wooden cover of the wooden packing case.

(4) Slit the seal, open, and fold out the top of the moisture-vaporproof barrier.

(5) Slit the seal and open the top of the outer corrugated carton.

(6) Remove an inner corrugated carton.

(7) Cut the tape that seals the inner corrugated carton and open the carton.

(8) Remove the cushioning from the carton.

(9) Lift the decade from the carton and place it on a solid table or workbench.

(10) Inspect the decade for damage.

(11) Check the contents of the package against the master packing slip.

c. Unpacking Domestic Packages. Unpack domestic packages as described in *b*(5) through (11) above.

Note. Save all packing material if possible. It can be used if the equipment is repacked for storage or shipment.

8. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 7 for uncrating and unpacking used or reconditioned equipment.

b. Check all decade switch controls for ease of operation.

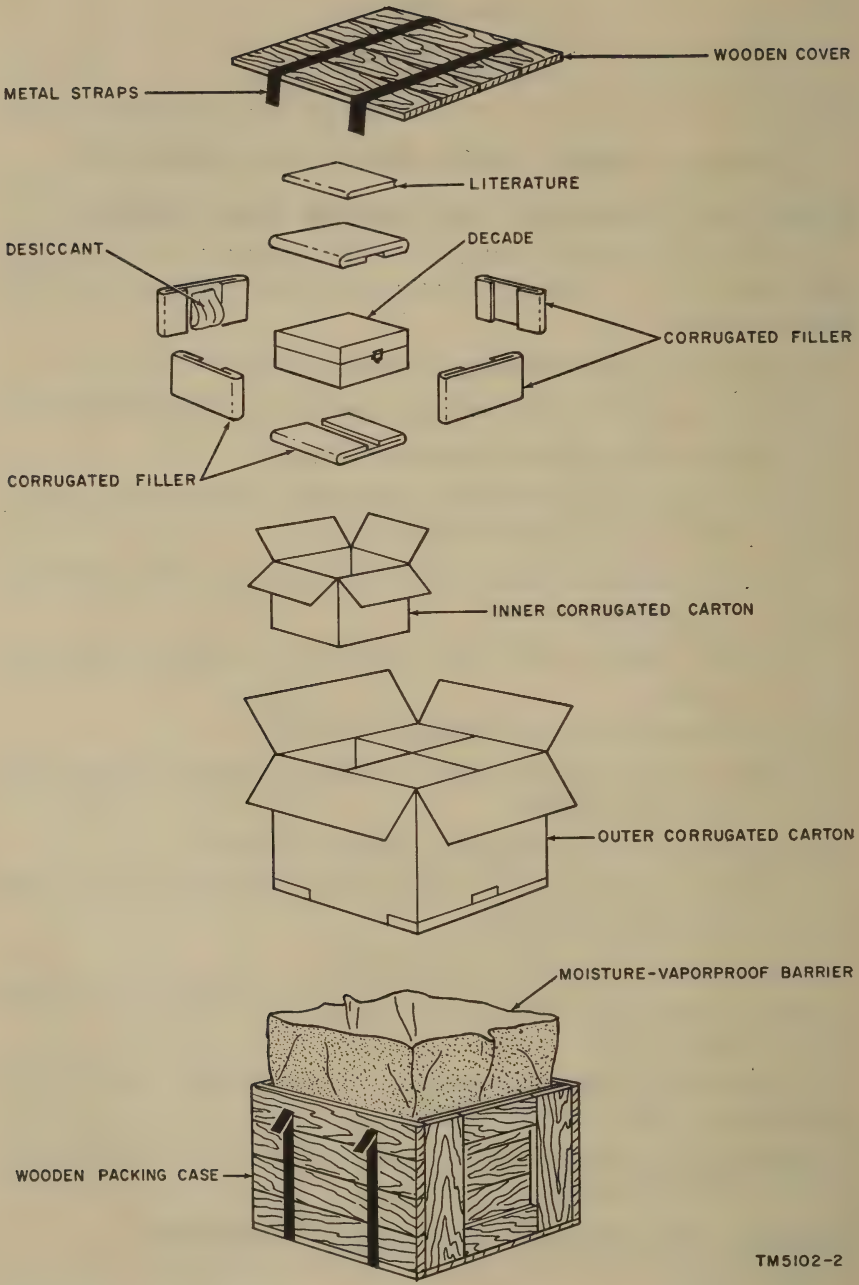


Figure 3. Decade Resistor ZM–16/U or ZM–16A/U, packaging diagram.

Section II. CONTROLS AND THEIR USES

9. General

This section describes the function of each of the decade switches of the ZM–16/U and ZM–16A/U. The operator must know the limits of resistance value for each decade switch; the operator must also know the current limit for the particular decade switch being used. Paragraph 10 lists this information in tabular form to make the information easily available for quick reference and use. Since the decade, if improperly used as a multiplier or shunt resistance, can damage the equipment with which it is used, proper use of the decade controls is important.

10. Controls and Binding Posts

a. The function of each control follows:

Controls		Function		
		Selects resistance (ohms)		Ohms per step
ZM-16/U (fig. 1)	ZM-16A/U (fig. 2)	From	To	
X 0.1—2 AMP MAX	X 0.1—4.5 AMP MAX	.1	1	.1
X 1—700 MA MAX	X 1—700 MA MAX	1	10	1
X 10—200 MA MAX	X 10—220 MA MAX	10	100	10
X 100—70 MA MAX	X 100—70 MA MAX	100	1,000	100
X 1,000—20 MA MAX	X 1,000—22 MA MAX	1,000	10,000	1,000
X 10,000—7 MA MAX	X 10,000 7 MA MAX	10,000	100,000	10,000
X 100,000—2 MA MAX	X 100,000—2.2 MA MAX	100,000	1 meg	100,000
X 1 MEG—0.7 MA MAX	X 1 MEG—0.7 MA MAX	1 meg	10 meg	1 meg
X 10 MEG—0.2 MA MAX	X 10 MEG—.05 MA MAX	10 meg	100 meg	10 meg

b. The function of each binding post is to connect the decade to the equipment used with the decade.

Section III. OPERATION UNDER USUAL CONDITIONS

11. Preoperational Instructions

a. Prior to connecting the decade in a circuit, always check the maximum current that may be flowing through the decade. To find the maximum current, divide the voltage that will appear across the decade by the decade resistance intended to be placed into the circuit.

b. Read the maximum allowable current on the *highest ohm decade switch* to be used. If the maximum allowable current is exceeded by the current that will flow through the decade (*a* above), do not connect the decade into the circuit. Excessive current may damage the decade switch.

c. The desired resistance is indicated by the decade switch control settings. For practical purposes, the zero setting (0) of all decade switches is zero resistance. To set any value resistance within the limits of the decade, place the proper decade switch controls to the correct digit of the number that makes up the resistance values. For example, if 4,527, 281.5 ohms resistance is desired, set the decade switch controls as follows:

Decade switch designation	X 10 MEG	X1 MEG	X 100,000	X 10,000	X 1,000	X 100	X 10	X 1	X 0.1
Decade switch control setting.	0	4	5	2	7	2	8	1	5

12. Operation

Note. The decade is not suitable for use in ac circuits with frequencies of over 60 cps.

To use the decade as a multiplier or shunt resistor substitute in meter circuits with approximate tolerances of ±1 percent, proceed as follows:

a. Check to be sure that the current that will flow through the decade is within the allowable range (pars. 3, 10, and 11).

b. Turn off the power in the equipment used with the decade (if required).

c. Set up the desired resistance on the decade switch controls (par. 11*c*) and connect the decade in the circuit. Use the decade binding posts as resistor terminals.

d. Turn on the power in the equipment used with the decade (if required).

e. When through using the decade, turn off power in the equipment used with the decade (if required), and disconnect the decade.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

13. General

The operation of the decade will be affected in regions where extreme climatic conditions prevail. Paragraphs 14 through 16 contain instructions to be followed when the decade is to be used under unusual climatic conditions.

14. Operation in Arctic Climates

a. Handle the decade carefully. Extreme cold my make some parts brittle.

b. If possible, keep the decade warm and dry. If this is not possible, keep the decade covered whenever it is not being used. If the decade has been exposed to the cold and is placed where it is warm, condensation may form on it. Dry the decade with a cloth.

15. Operation in Tropical Climates

a. Place the decade under a suitable tarpaulin for overnight storage to minimize condensation which is prevalent in tropical climates.

b. Remove moisture from the decade before operation.

16. Operation in Desert Climates

a. Keep the decade free from dust. Perform more frequent preventive maintenance services (par. 20).

b. An extreme drop in temperature at night may cause moisture condensation on the decade. When possible, keep it covered. Remove moisture from the decade.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. PREVENTIVE MAINTENANCE SERVICES

17. Tools and Materials

The following organizational tools and materials are used to perform preventive maintenance:

Tool Equipment TK–21/G
Cleaning Compound (Federal stock No. 7930–395–9542)
Cloth (or brush)
Sandpaper, No. 000

18. Meaning of Preventive Maintenance

Preventive maintenance is work performed on the decade to keep it in good working condition. Preventive maintenance will minimize breakdowns.

19. Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion from the decade surface.

b. Use a clean, dry, lint-free cloth or a dry brush for removing dust or dirt.

c. If dirt is difficult to remove with a dry cloth, use a cloth moistened with Cleaning Compound. Follow up with a dry cloth.

Warning: Prolonged breathing of Cleaning Compound fumes is dangerous. Make sure adequate ventilation is provided. Cleaning Compound is flammable; do not use near a flame.

d. Use dry compressed air, if available, at a line pressure not exceeding 40 pounds per square inch to remove dust from difficult places in the equipment. Be very careful to prevent mechanical damage to the equipment.

Caution: Always direct the first blast of compressed air toward the floor to clear condensed moisture from the line.

20. Preventive Maintenance Services

a. Daily Services.

(1) Clean the exterior of the case and the panel face.

(2) Check the operation of the decade switches for looseness or binding.

b. Weekly Services.

(1) Clean the interior of the case, the decade switch surfaces, and the binding posts.

(2) Check the action of the decade switch fingers at each contact point.

c. Monthly Services.

(1) Check the binding posts for dirt, corrosion, and tightness of nuts on the back of the decade panel.

(2) Check decade switches for dirt, corrosion, loose contacts, and unsatisfactory mechanical action.

(3) Check mountings and machine screws for looseness.

(4) Check all terminals and connections for looseness or corrosion.

(5) Check moistureproofing and fungiproofing coatings for breaks. Retouch breaks with varnish and a brush. Be extremely careful to avoid coating the decade switch contacts.

(6) Check the ZM–16/U case finish for scratches and bare spots. Retouch the case if necessary.

Section II. WEATHERPROOFING AND LUBRICATION

21. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions that prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moitsure, and extreme temperatures are harmful to most materials. Protect the equipment according to the climate where the equipment is intended for use as follows:

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

22. Lubrication

No lubrication is required for the decade. Application of a lubricant to the decade switch contacts or switch arms will eventually impair switch operation.

CHAPTER 4

FIELD MAINTENANCE

Note. This chapter contains information pertinent to field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

23. Theory of Operation
(figs. 7 and 8)

a. General. The inherent capacitance and inductance of the decade limits the practical use of the decade to dc circuits, and to ac circuits up to about 60 cps. With the decade switch controls set to 100 megohms, the capacitance between the binding posts is less than 10 micromicrofarads. With all decade switch controls at their 0 positions, the decade resistance is between .045 and .05 ohm. The decade switch control X 0.1, when in position 1, actually presents a resistance of .1 plus .05 ohm (or .15 ohm) in the circuit in which the decade is placed. When the decade is used as a shunt resistor, this error must be taken into account. All decade switches are wired in series with each other.

b. Detailed Analysis.

(1) The binding posts (E2 and E1) terminate all nine decade switches individually or collectively, depending on the positions of the decade switch controls.

(2) All decade switch resistors are wired in series with each other and all decade switches are wired in series with each other. The amount of resistance in this series circuit is selected by the decade switch control (par. 10). Therefore, with the decade connected *in series* with some external circuit, the selected amount of resistance is placed *in series* with that external circuit.

(3) With the decade placed *across* some external circuit, the selected amount of resistance is then acting as a *load* or shunt.

(4) The amount of current flowing through the decade resistors is directly proportional to the voltage across the binding posts of the decade.

(5) Maximum allowable current value, indicated below each decade switch control, is greatest for the X 0.1 control and least for the X 10 MEG control.

24. Troubleshooting Procedures

a. The test listed in *c* below will aid in isolating the source of trouble. Follow the procedure in the order given.

b. Visual inspection frequently reveals where the trouble exists. The inspection may prevent possible further damage to the decade because such an inspection may make elaborate servicing methods unnecessary.

c. Look for the following before performing any other service to the equipment.

(1) Corrosion.
(2) Loose connections or screws.
(3) Defective binding posts or decade switch contacts.
(4) Broken wires.
(5) Charred resistors.

25. Troubleshooting Data

Check the schematic diagram in this manual (fig. 7 or 8). Refer also to figure 5 or 6 for decade switch location and identification information.

26. Test Equipment Required

The items of test equipment required for troubleshooting the decade are listed below. Technical manuals and common names associated with each item also are listed.

Test equipment	Technical manual	Common names
Multimeter TS–352/U	TM 11–5527	Multimeter.
Electronic Multimeter TS–505/U	TM 11–5511	Electronic multimeter.
Resistance Bridge ZM–4/U (Test Set I–49).	TM 11–2019	Resistance bridge.
Meter Test Set TS–682A/GSM–1	TM 11–2535B	Meter test set.

27. General Precautions

When the decade is being serviced, observe the following precautions:

a. When replacing a part, be careful not to damage or disturb other parts.

b. Before a part is unsoldered, note the position of leads so that they may be replaced in their original positions.

c. Use sufficient solder and heat to make a hot soldered joint. A poorly soldered (or cold soldered) joint is difficult to locate.

d. When replacing a wire, use a wire of the same gage or larger gage of the same length. Failure to do so will result in increased resistance in the circuit.

28. Troubleshooting

If the decade resistor fails to operate satisfactorily after having been cleaned carefully and serviced, make the following checks to localize and correct trouble:

a. Checking Decade with Ohmmeter.

Note. Multimeter TS–352/U is used as an ohmmeter to check the continuity and approximate resistance value of the decade resistors. If more than ±1 percent deviation from the rated value of a particular resistor is suspected, use Resistance Bridge ZM–4/U (*b* below) to check that particular resistor.

(1) Set all the decade switch controls to 0.

(2) Connect the multimeter ohmmeter leads to the binding posts of the decade. The ohmmeter reading on the lowest ohmmeter scale of the multimeter should be approximately .05 ohm.

(3) Starting with the X 0.1 decade switch control, place the decade switch control in each of its positions, starting with position 1. The ohmmeter should indicate the value of the selected decade resistor within the tolerance of the multimeter.

(4) After completing the full rotation of the X 0.1 decade switch control, position the decade switch control on 0. Repeat the action using the X 1 decade switch control.

(5) Check the individual resistors of all nine decade switches in the manner described above.

b. Checking Decade with Resistance Bridge.

Note. Resistance Bridge ZM–4/U is an accurate instrument used to measure the resistance value of each of the individual decade resistors or of the complete decade switch (except the X 10 MEG decade switch (*c* below)). The resistance bridge is more accurate than the multimeter (*a* above) and is used to measure the value of the decade resistor within the tolerance of the decade (±1 percent for all decade switches except the X 0.1 decade switch resistors, which is rated at ±2 percent).

(1) Set all decade switch controls to their 0 positions.

(2) Connect the resistance bridge to the decade binding posts.

(3) Set the resistance bridge at its most sensitive range and note the reading. The reading should not exceed .05 ohm.

(4) Tap the decade switch controls while observing the resistance bridge reading. If the resistance bridge null detector (galvanometer) indicates a *maximum opposite deflection,* inspect the connections at each decade switch. Look for a defective or loose solder joint.

(5) With all other decade switch controls at their 0 positions, turn the X 0.1 decade switch control clockwise one step at a time and note the resistance bridge reading for each step. The reading for each decade switch step should correspond to the value indicated by the decade switch control setting (par. 10) plus approximately .05-ohm wiring and contact resistance (par. 4). Tap the decade switch control at each setting for defective decade switch contacts.

(6) Repeat the procedure given in (5) above for each of the succeeding eight decade switches. The checking procedure for the last decade switch is described in *c* below.

(7) Replace a defective resistor or decade switch (par. 29*a* and *b*).

(8) After a part has been replaced, repeat the procedure given in (5) above; operate the replaced or repaired decade switch to make sure that the decade switch functions properly.

c. Checking X 10 MEG Decade Switch with Meter Test Set and Electronic Multimeter (fig. 4). To measure the resistance of the individual resistors or of the entire X 10 MEG decade switch of 100 megohms, proceed as follows:

(1) Connect Meter Test Set TS–682A/GSM–1 to Electronic Multimeter TS–505/U as shown in A, figure 4. Consult the respective technical manuals TM 11–2535B and TM 11–5511 for details in making the connections and for operating the equipment.

(2) Adjust the output of the meter test set to 2 volts dc.

(3) Note the reading on the voltmeter of the electronic multimeter. It should be 2 volts dc.

(4) Disconnect one lead between the two instruments and connect the decade in series with the meter test set and the electronic multimeter as shown in B, figure 4.

(5) With all other decade switch controls at their zero (0) positions, turn the X 10 MEG decade switch control clockwise to position 1.

(6) Adjust the output of the meter test set until the reading on the electronic multimeter is 2 volts dc. Note the reading on the meter test set.

(7) Use the following formula to determine the resistance of the decade switch resistor being measured. (The resistance determined should be the same as the value indicated on the decade panel, ±1 percent.)

Formula:

$$\frac{V_2 - V_1}{V_1} \times 20 = R$$

Where: V_1 is the voltage indicated on the electronic multimeter ((3) above); V_2 is the voltage indicated on the meter test set ((6) above); R is the value of the decade resistor in megohms; and 20 is the input resistance of the electronic multimeter in megohms.

For example, if the meter test set reading is 3 volts (V_2) and the electronic multiater reading is 2 volts (V_1) then, $\frac{3-2}{2} \times 20 = .5 \times 20 = 10$ megohms.

Ten megohms is correct for the decade resistor selected for measurements ((5) above).

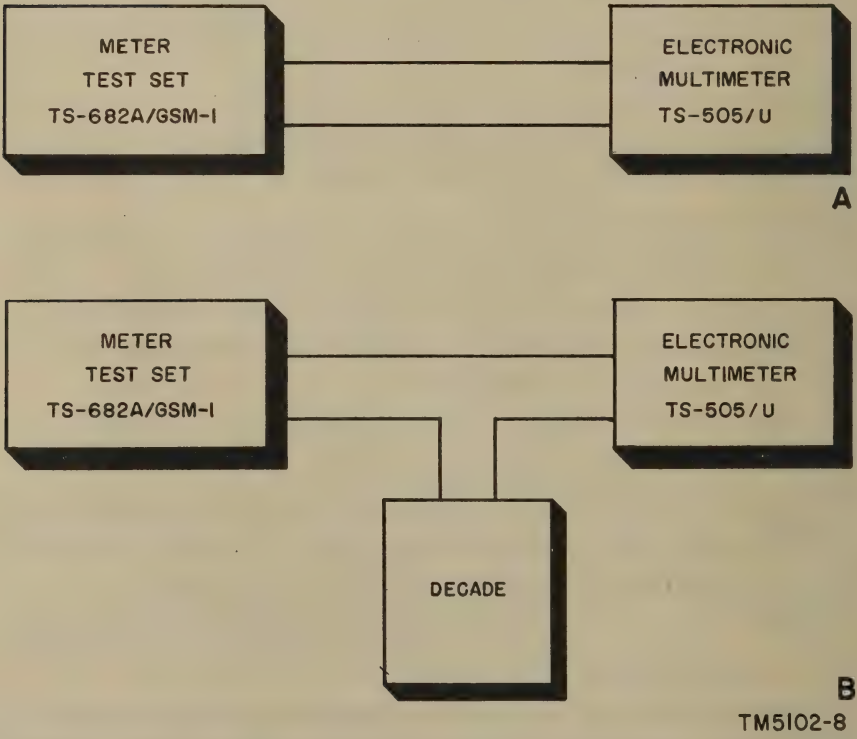


Figure 4. Test setup for measuring resistance value of X 10 MEG decade switch.

(8) Repeat the procedure in (5) through (7) above for each succeeding X 10 MEG decade switch step.

Section II. REPAIRS

29. Replacement of Parts
(figs. 5 and 6)

All parts of the decade are accessible and replaced easily. Careless replacement of parts often creates new faults. Refer to paragraph 27 before making any replacements.

a. Replacement of Individual Resistor. To replace a resistor, proceed as follows:

(1) Remove the four machine screws that secure the panel and lift the panel from the case.
(2) Remove the decade switch from the panel (*b* below).
(3) Remove the soldered connection; use a pencil soldering iron and a heat shunt.
(4) Replace the defective resistor with one of the same construction and value.
(5) Replace the decade switch.

b. Replacement of Decade Switch. To replace a decade switch, proceed as follows:

(1) Remove the panel from the case (*a* above).
(2) Label the two leads to be removed so that they may be replaced in the proper location.
(3) Remove the two soldered connections; use a pencil soldering iron and a heat shunt.
(4) Remove the decade switch control knob and hexagonal nut.
(5) Pull out the decade switch from the panel hole.
(6) Remove resistors and attach them to the new decade switch.
(7) Reinstall the new decade switch.

c. Replacement of Binding Post. To replace a binding post, proceed as follows:

(1) Remove the panel from the case (*b* above).
(2) Remove the two soldered connections to the binding posts by using a pencil soldering iron.
(3) Remove the nut and lockwasher that hold the binding post in place, and pull out the binding post.
(4) Install a new binding post by reversing the order of instructions given above.

30. Refinishing

When the finish on the case of the ZM–16/U has been scarred or damaged, prevent corrosion by touching up bared surfaces. Use No. 000 sandpaper to clean the surface down to the bare metal. Be sure to obtain a smooth bright finish. In severe cases, clean with Cleaning Compound before sanding the surface. Apply paint to the repaired portions with a small brush. The ZM–16A/U plastic case does not require painting.

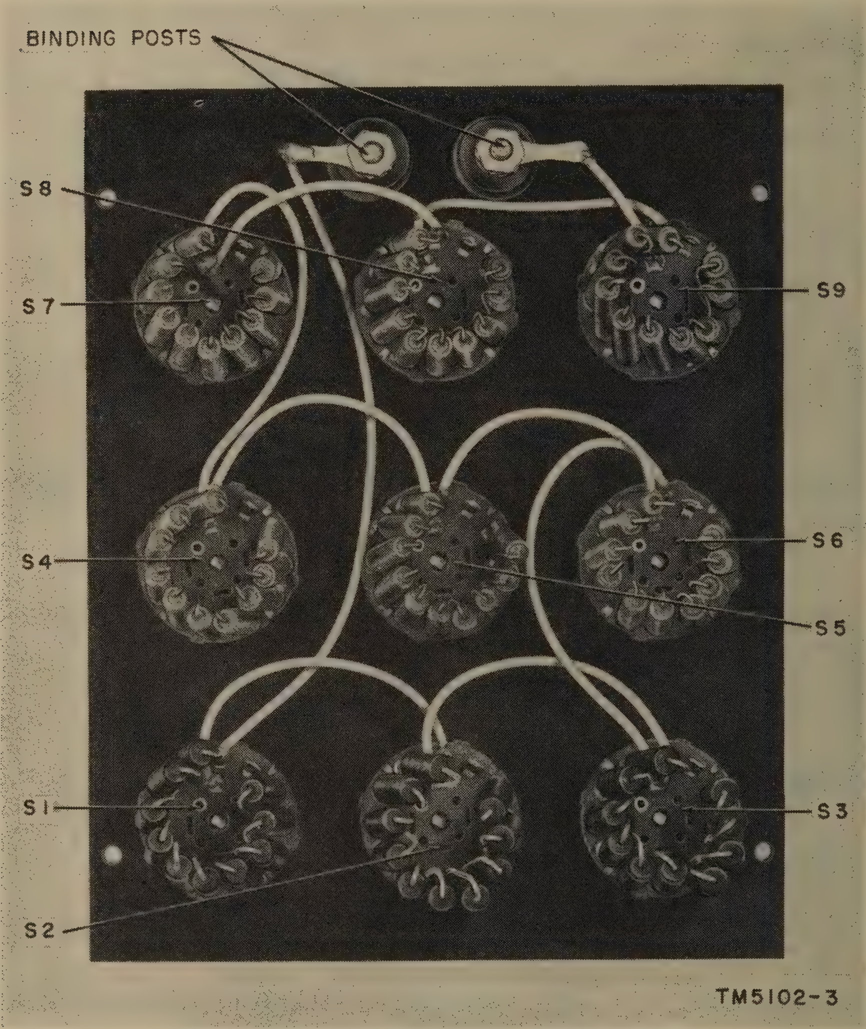


Figure 5. Rear view of decade (ZM–16/U).

31. Final Testing Procedure

When a resistor, decade switch, or binding post has been replaced, recheck the decade as described in paragraph 28. Make sure the decade is now functioning properly.

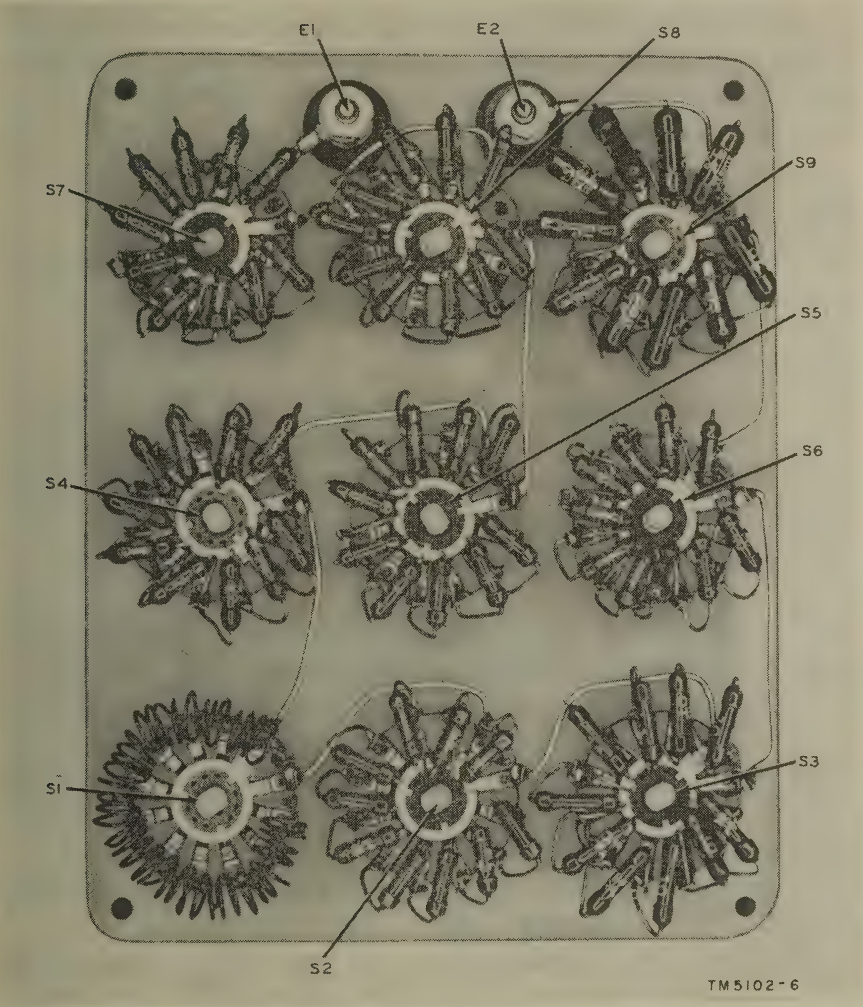


Figure 6. Rear view of decade (ZM–16A/U).

CHAPTER 5

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

32. Field Repacking for Shipment or Limited Storage

a. General. The field repacking procedures described below are used to prepare the decade for shipment to the Zone of the Interior and intertheater areas. Decades, packaged as described below, may be stored for limited periods.

b. Packaging Material Required. The following material is required for packaging a decade:

Materials	Amount
Waterproof barrier material	2½ sq ft
Corrugated, single-faced, flexible fiberboard	4½ sq ft
Gummed paper tape	4½ ft
Pressure-sensitive, water-resistant tape	2 ft

Note. Wooden shipping boxes are required for packing the decade for quantity shipments. Wooden shipping boxes must be lined inside with a fitted, sealable waterproof, case liner. For intertheater shipments, metal strapping must be used around the wooden shipping boxes.

c. Packaging the Decade. Package each decade as follows:

(1) Inclose the technical literature in a close-fitting bag of waterproof barrier material. Seal the seams with pressure-sensitive, water-resistant tape.

(2) Wrap each decade, together with the bag containing the technical literature, in two thicknesses of corrugated, single-faced, flexible fiberboard. Each thickness of the fiberboard shall be applied separately and secured with gummed paper tape.

d. Packing the Decade. Pack the packaged decades in a wooden box shipping container as follows:

(1) Place the desired quantity of packaged decades in the nailed wooden box fitted with a waterproof liner. Fabricate the box to fit the contents snugly.

(2) Seal the liner.

(3) Apply the box cover and nail it securely.

(4) Use metal strapping around the box for interheater shipment only.

(5) Mark the boxes in accordance with the requirements of section II, SR 55–720–1.

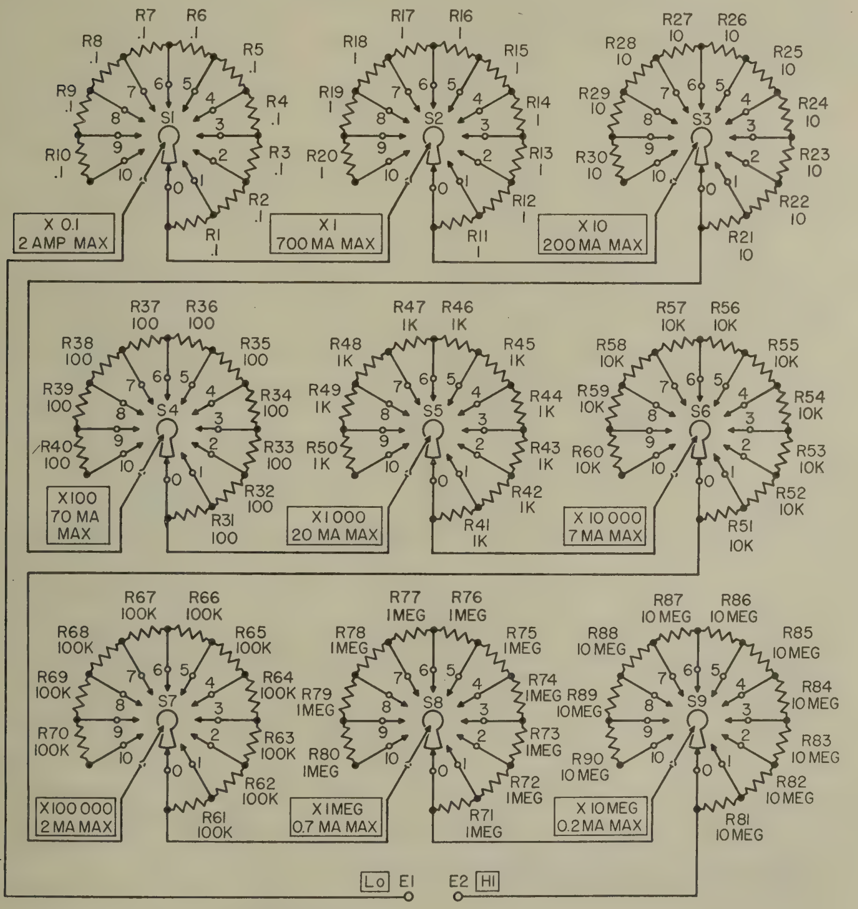
33. Methods of Destruction

Note. The demolition procedures outlined in *a* through *f* below will be used to prevent the enemy from using or salvaging the decade. Demolition of the decade will be accomplished only upon order of the commander.

a. Smash. Smash the controls, switches, and binding posts; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut all wires; use axes, handaxes, or machetes.

c. Burn. Burn the wiring and the technical manuals; use gasoline, kerosene, oil, flamethrowers, or incendiary grenades.



NOTES:
1 - UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS.
2 - SWITCHES ARE VIEWED FROM END OPPOSITE THE KNOB.
3 - ▭ INDICATES EQUIPMENT MARKING

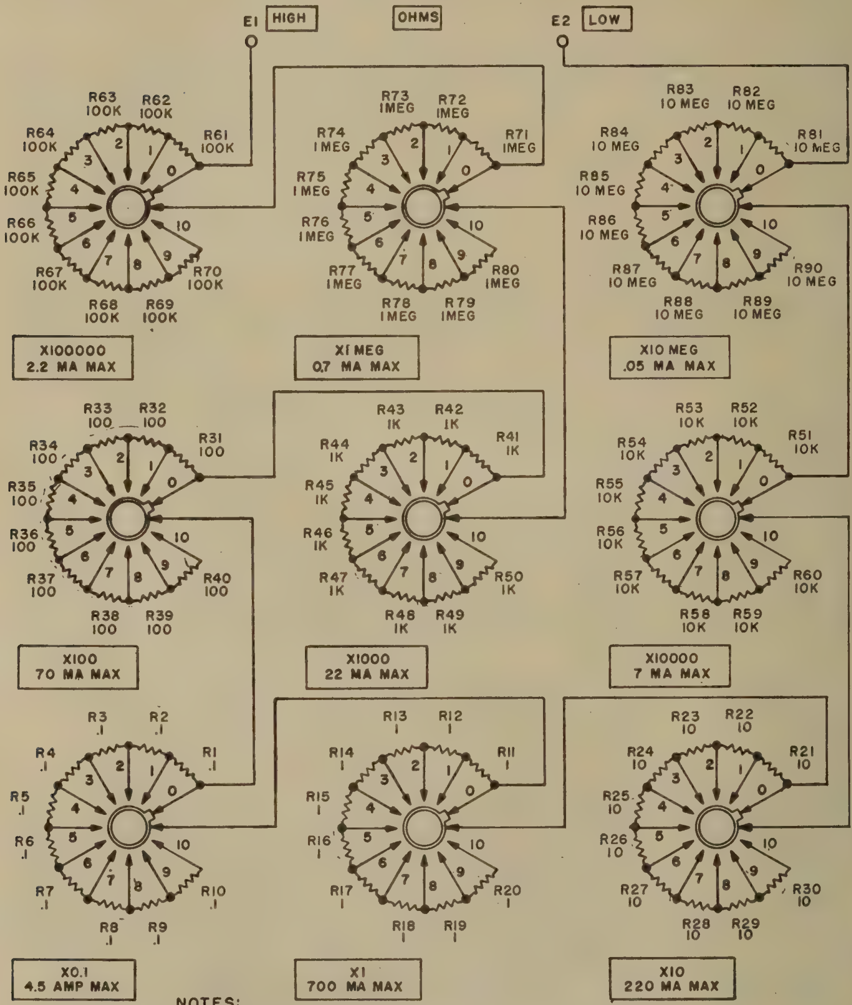
TM5102-4

Figure 7. Decade Resistor ZM–16/U, schematic diagram.

d. Bend. Bend the panel and case of the ZM–16/U. Break the case of the ZM–16A/U.

e. Explosives. Use firearms or grenades.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, foxholes, or throw them into streams.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS.
2. SWITCHES ARE VIEWED FROM END OPPOSITE THE KNOB.
3. ▭ INDICATES EQUIPMENT MARKING

TM5102-7

Figure 8. Decade Resistor ZM–16A/U, schematic diagram.

[AG 412.42 (7 Dec 55)]

BY ORDER OF THE SECRETARY OF THE ARMY:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

OFFICIAL:
JOHN A. KLEIN,
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NG: State AG (6); Units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

☆ U. S. Government Printing Office: 1955—360518

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